DETERMINATION OF THE PHYSICAL CONDITION OF FISH

I. SOME BLOOD ANALYSES OF THE SOUTHERN CHANNEL CATFISH

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The abatement of pollution has been a major problem in conservation of fish and other aquatic organisms. Consequently, a great deal of effort has been expended on establishing standards for the physical and chemical qualities of fresh water favorable to fish life and to the study of the effects of many pollutants on fish. The published data on fish blood, however, are insufficient for use in determining the physical condition of fish by blood analyses. In pollution studies such data are highly desirable for many of the important native food fish such as the trout, crappie, black bass, sunfish and catfish.

All effects of pollutants on fish may not be detected by a study of the blood alone. Ellis (1937) demonstrated that some substances are injurious to the gills and other external structures of the fish without any marked absorption beyond the gills, with death resulting from anoxemia and interference with the excretory functions of the gills. Other substances cause death by specific toxic action after absorption through the gills and other external structures, and the lining of the gastrointestinal tract. In many of these cases, especially when the respiratory and circulatory functions are impaired, the illness or poor physical condition of the fish may be expected to be reflected in the condition of the blood.

In many instances the low concentration of pollutants may make streams and lakes unfavorable to fish without killing them at once in noticeable numbers. Nevertheless, the fish in these polluted lakes and streams may be harmed in various ways. The polluting substance may reduce the available dissolved oxygen in the water below the level required by a thriving fish fauna. Toxic substances may accumulate within the fish thereby lowering their natural resistance to disease and adverse conditions. The number and quality of food organisms may be reduced to such a low level that the fish are not properly nourished. These unfavorable conditions may go unnoticed until high temperatures and low dissolved oxygen concentrations of the water during the hot summer months kill large numbers of fish which otherwise would have lived in unpolluted water.

The present report is an attempt to establish the mean values of the haemoglobin concentration, number of erythrocytes, per cent cell volume and specific gravity of the blood of a small population of the southern channel catfish, *Ictalurus lacustris punctatus* (Rafinesque). These values may be of assistance in differentiating individuals of this species in good physical condition from those in poor physical condition. The southern channel catfish was selected for this work because of its importance as a food fish throughout

Table 1. The means, standard deviations, and probable error of the means for the specific gravity, number of erythrocytes, per cent cell volume, and concentration of hemoglobin for the blood of a small population of the southern channel catfish, *Ictalurus lacustris punctatus* (Rafinesque)

	Mean	Standard Deviation	P.E. Mean
Specific Gravity	1.0365	0.0040	±0.00036
Erythrocytes per cu.mm.	2,175,000	371,000	±37,300
Cell Volume per cent	32.3	5.3	±0.68
Hemoglobin gm./100 ml.	7.1	1.13	±0.15

the Gulf and Mississippi Valley regions where it is common in streams and lakes. A further advantage in using this species is that is has been used extensively in physiological assay work in connection with a variety of pollution problems in the laboratory, thus providing considerable supplementary information for reference.

Materials and Methods

The channel catfish were used either the same day collected or saved for later use by holding in a large concrete raceway filled with flowing water to a depth of three to five feet. Chopped spleens and hearts of cattle and swine were fed to the captive fish on an average of once every ten days.

When blood was desired, a fish was taken from the water, pithed, and slit open in the mid-ventral line at the level of the pectoral girdle to expose the heart. The required amount of blood for the analyses was withdrawn from the conus arteriosus into a small paraffin-lined dish and used immediately without the addition of an anti-coagulant. Seventy-six individuals were used. In some instances two or three different analyses were made from the same sample of blood while in others only one kind of analysis was made. The standard length of the test animals ranged from 125 to 580 cm. and the wet weight from 37 to 3,060 grams.

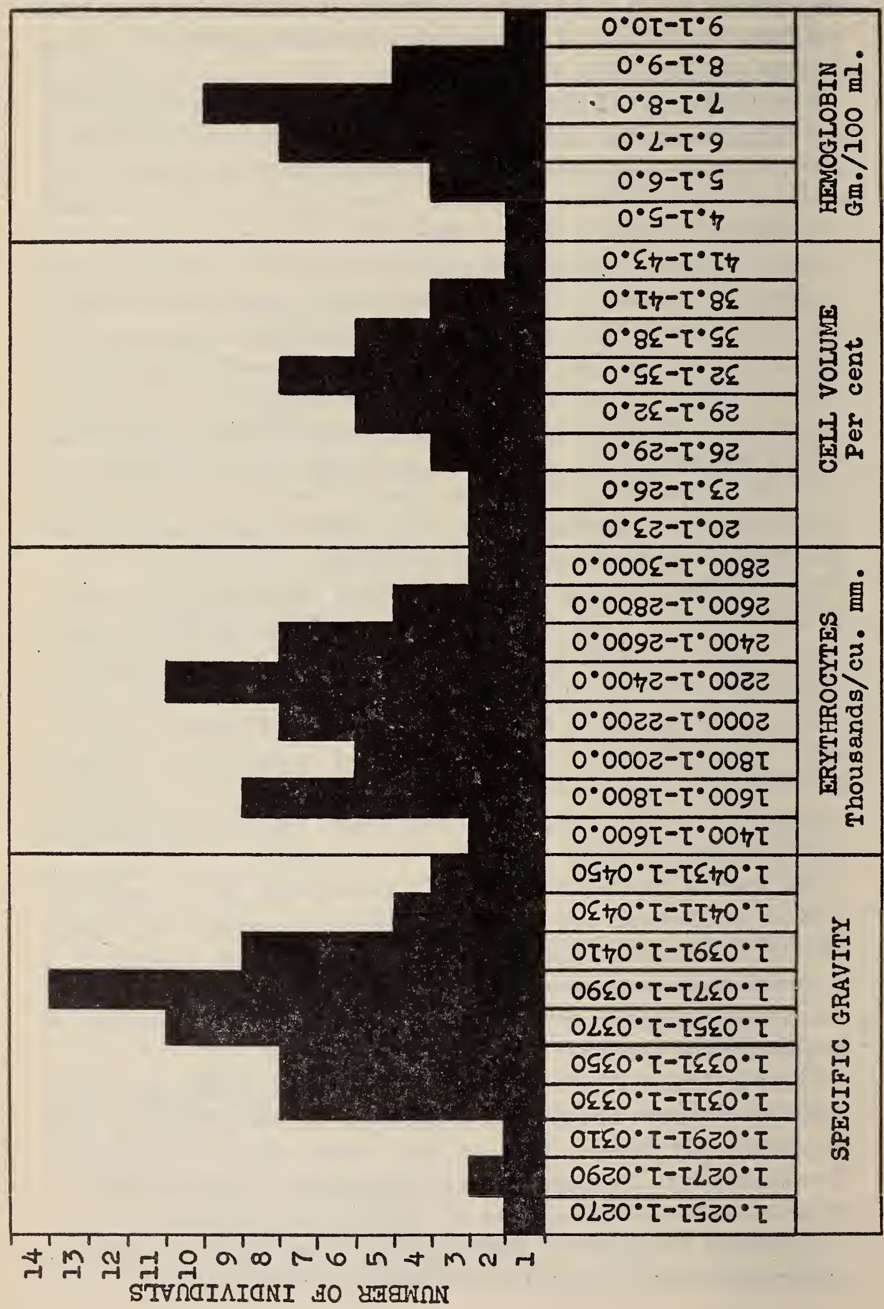
The data collected for each of blood characteristics studied were treated statistically. In order to demonstrate the relationship between the apparent physical condition of the fish and the values for hemoglobin, specific gravity, and cell volume, the data for twenty fish was assembled in tabular form.

The concentration of hemoglobin was determined photoelectrically, using the method described by Hoffman (1941) for mammalian blood, in which 0.1 ml. of freshly drawn blood is laked and thoroughly aerated by shaking in 20 ml. of 0.1 per cent sodium carbonate solution and read in a Cenco-Sheard-Sanford Photelometer equipped with a green filter. Each reading thus obtained was translated into grams of hemoglobin per 100 ml. of blood by reference to a calibration curve, which had been standardized by the Wong iron method.

The specific gravity of the blood was obtained by following the method of Barbour and Hamilton (1926), in which the falling-time of a measured drop of blood through a 30 cm. column of a bromobenzene-zylene mixture is compared with that of an equivalent (equal volume) drop of a solution of potassium sulfate of known specific gravity.

The per cent cell volume was secured by centrifuging a small quantity of whole blood in an hematocrit for 30 minutes at 2100 revolutions per minute. Both red and white cells are included in the values given. Determinations on unoxalated blood and blood in isotonic oxalate solutions were not significantly different.

A Spencer "Bright-line" Haemocytometer was used to make the erythrocyte counts, using Toison's solution as the diluent.


HEMOGLOBIN
Gm./100 ml.
4.1-5.0
5.1-6.0
6.1-7.0
7.1-8.0
8.1-9.0
9.1-10.0
CELL VOLUME
Per cent
20.1-23.0
23.1-26.0
26.1-29.0
29.1-32.0
32.1-35.0
35.1-38.0
38.1-41.0
41.1-43.0
ERYTHROCYTES
Thousands/cu. mm.
1400.1-1600.0
1600.1-1800.0
1800.1-2000.0
2000.1-2200.0
2200.1-2400.0
2400.1-2600.0
2600.1-2800.0
2800.1-3000.0
SPECIFIC GRAVITY
1.0251-1.0270
1.0271-1.0290
1.0291-1.0310
1.0311-1.0330
1.0331-1.0350
1.0351-1.0370
1.0371-1.0390
1.0391-1.0410
1.0411-1.0430
1.0431-1.0450
NUMBER OF INDIVIDUALS
1
2
3
4
5
6
7
8
9
10
11
12
13
14

In addition to the foregoing procedures, the apparent physical condition as ascertained by superficial external examination, sex, wet weight and standard length were noted in most cases for each fish.

Results

The data for the specific gravity, number of erythrocytes, per cent cell volume and concentration of hemoglobin are graphically represented in figure 1, in which the graphs show the range and frequency of the values obtained for each of these blood characteristics. The range of values was appreciable in each case; specific gravity ranged from 1.0259 to 1.0443, concentration of hemoglobin from 4.8 to 9.3 grams per 100 ml., number of erthrocytes from 1,456,000 to 2,928,000 per cu mm., and cell volume from 21 to 41 per cent. Statistical analyses of the data (table 2) indicate that the

Table 2. Concentration of hemoglobin, per cent cell volume and specific gravity of the blood of the southern channel catfish, *Ictalurus lacustris punctatus* (Rafinesque), with respect to sex, wet weight, standard length and apparent physical condition.

Sex	Weight gm.	Length cm.	Hemoglobin gm./100 ml.	Cell Volume per cent	Specific Gravity	Physical Condition
Male.......	244	265	8.7	37.5	1.040	Good
Female.....	108	225	4.8	21.1	1.027	Poor
Male.......	197	247	6.8	33.5	1.035	Fair
Female.....	421	323	9.3	38.7	1.044	Good
Male.......	360	300	6.5	31.6	1.037	do.
Male.......	290	280	7.7	35.8	1.042	do.
Male.......	102	213	7.3	34.5	1.039	do.
Female.....	155	233	7.9	38.7	1.040	do.
Male.......	97	214	5.7	28.5	1.032	Poor
Male.......	505	345	7.5	36.5	1.038	Good
Male.......	215	265	5.7	25.8	1.032	Fair
Male.......	155	231	6.3	33.5	1.035	do.
Female.....	185	219	6.3	31.1	1.035	do.
Female.....	255	266	7.0	31.2	1.037	Good
Male.......	275	285	8.3	36.1	1.041	do.
Female.....	68	183	5.9	26.6	1.033	Poor
Male.......	342	317	8.0	34.9	1.040	Good
Female.....	90	190	7.3	34.2	1.037	Fair
Male.......	490	335	7.5	30.7	1.040	Good
Male.......	685	380	6.7	27.2	1.038	do.

chances are very good (at least 20 to 1) that the true mean specific gravity for any similar group of channel catfish will be 1.0365± 0.0011 (3X P.E. mean). Similarly, the mean number of erythrocytes per cu. mm., per cent cell volume and grams of hemoglobin per 100 ml. will be 2,175,000± 112,000, 32± 2.0 and 7.1± 0.45 respectively.

The relationship between the apparent physical condition and the hemoglobin concentration, per cent cell volume and the specific gravity for twenty fish is shown in table 2. In general the variations of values for these characteristics were in the same direction when correlated with the physical condition of the fish. The lowest values obtained were associated with fish in obviously poor physical condition and the higher ones with those in better condition.

Summary

In view of the insufficiency of published physiological data for determination of the physical condition of certain important freshwater food fish, an attempt is made to establish the mean values for the specific gravity, number of erthrocytes, per cent cell volume and concentration of hemoglobin for the blood of the southern channel catfish, *Ictalurus lacustris punctatus* (Rafinesque). Data obtained from the study of seventy-six individuals gave the mean value for specific gravity as 1.0365 ±0.0011, for the number of erythrocrytes as 2,175,000± 112,000 per millimeter, for cell volume as 32± 2.0 per cent and for hemoglobin, 7.1 ±0.45 grams per 100 milliliters. The lowest values obtained were associated with fish in obviously poor physical condition and the higher ones with fish in apparently good physical condition.

Literature Cited

BARBOUR, H. G., and W. F. HAMILTON
1926. The falling drop method for determining specific gravity. *Jour. Biol. Chem.*, 69: 625-640.

ELLIS, M. M.
1937. Detection and measurement of stream pollution. *Bull.* No. 22, *U. S. Bur. Fish.*, 48: 365-437.

HOFFMAN, W. S.
1941. *Photelometric Clinical Chemistry.* William Morrow and Company, New York.

Quart. Journ. Fla. Acad. Sci., 11(4) 1948(1949)

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Figure 1. Range and frequency of the values for specific gravity, number of erythrocytes, per cent cell volume and hemoglobin concentration of a small population of the southern channel catfish, *Ictalurus lacustris punctatus* (Rafinesque)